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News & Comments

Warm-Bloodedness Emerged from Mammals' Shrinking Inner Ears

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Besides mammals, birds, the only living dinosaurs, also have warm-bloodedness or endothermy. It is endothermy, however, that allows mammals to regulate their internal body temperatures by controlling their metabolic rates. In ancient climates, mammals were able to adapt to a wide range of environmental niches from pole to equator. It has been unclear when endothermy evolved, however. Using the size of tiny structures in the inner ears of ancient mammals, an international research team has determined when ancient mammals became warm-blooded. As far back as 300 million years ago, researchers have proposed dates based on fossil analyses of growth rates and oxygen isotopes in bones. Ricardo Arajo, a vertebrate paleontologist at the University of Lisbon, aims to answer that mystery using vertebrate fossils and their inner ear structures. Each vertebrate inner ear contains a labyrinth of semicircular canals filled with fluid that reacts to head movements, brushing tiny hair cells in the ear and assisting in balance. Depending on the body's temperature, that fluid can thicken or thin.

According to Arajo and his team, ear canal size and shape are influenced by body temperature. Warm-blooded animals have smaller canals leading to less viscous fluid. It may be possible to determine when warm-bloodedness emerged in the mammal lineage by tracing the shape of fossilized inner ear canals over time. A tool called the "thermo-motility index" was developed to test this hypothesis in 341 different vertebrates. Based on size differences, this index closely correlates with an animal's body temperature, whether it be a fish, a reptile, or a mammal. Mammals had high index values; reptiles had low values.

A fossilized ear canal of 56 extinct mammal ancestor species was then analyzed using this index. They were surprised to find that 233 million years ago, inner ear morphology had undergone a drastic change. Endothermy would have evolved abruptly around that time if body temperature increased between 5 and 9 degrees Celsius. Although birds and mammals have benefited from evolving warm-bloodedness, it's unlikely to be the sole explanation for endotherm dominance on Earth today. The findings of this research back to another study published in Nature earlier this year in which researchers used similar techniques to conclude that most dinosaurs were not ectotherms like the modern reptiles they resemble but warm-blooded animals like birds and mammals.

KEYWORDS

Animal physiology, neurophysiology, palaeontology, ear, endolymph, endothermy, fossil, inner ear, mammal, mammaliamorpha, metabolism, temperature, ear canal, history, evolution, warm-blooded